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Threshold level of soil zinc for optimum production of ginger (*Zingiber officinale* Rosc.)[1]

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Abstract

A field experiment was conducted at Peruvannamuzhi (Kerala), for two years to evaluate the optimum level of zinc (Zn) content in soils for maximizing production of ginger (*Zingiber officinale*) on an *Ustic Humitropept* with varying levels of Zn fertilizer. The mean rhizome yield of two years was higher in plots where Zn @ 5 kg ha^{-1} was applied. A cubic model described satisfactorily the relationship between mean rhizome yield and fertilizer application rate. The optimum fertilizer dose for obtaining maximum rhizome yield was determined as 6 kg ha^{-1} of Zn. The maximum limit of soil DTPA-Zn for obtaining higher rhizome yield was 3.4 mg kg^{-1}.

Key words: ginger, response function, threshold level, yield, zinc, *Zingiber officinale.*

The role of micronutrients in agricultural production has been viewed with greater importance in recent years as their limited availability in soils restricts crop productivity. Ginger (*Zingiber officinale* Rosc.) is an exhaustive rhizomatus crop whose productivity is also affected by deficiency of micronutrients (Roy *et al.* 1992). Ginger is mainly grown in red and laterite soils of India in Kerala, Karnataka, Orissa, West Bengal, Maharashtra and north eastern states. These soils are characteristically acidic and deficient in major and micronutrients due to loss from runoff or excess leaching owing to high rainfall. Soil and plant analysis of samples from across the country indicated 49% mean deficiency of zinc (Zn) with acid soils of Meghalaya having the highest deficiency rate of 57%. For getting better response to the applied nutrient, their threshold limits must be defined with reference to the soil characteristics for individual crops as soils and crops vary widely in their nutrient supply and utilization efficiency. Sadanandan & Hamza (1998) have studied the effect of combination of micronutrients namely, zinc, boron and molybdenum applied along with major nutrients on yield and quality of ginger and turmeric. However, since no information is available on the threshold level of Zn in soils for getting response in ginger, a study was undertaken to evaluate the optimum level of Zn in soils for obtaining higher productivity in the crop.

The field experiment was conducted at Indian Institute of Spices Research, Experimental Farm, Peruvannamuzhi (Kerala) (*Ustic Humitropept*), for two years (2001 and 2002) with var. Varada as test crop. As ginger is an exhaustive crop and vulnerable to diseases, it is not cultivated in the same place during consecutive years.

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Hence the crop was grown in two different plots having the following chemical properties during consecutive years. The experimental soils were clayey with pH 4.9 and 5.6 (1:2, soil:water), available N 114 and 270 mg kg^{-1}, Bray's P 3.3 and 11.7 mg kg^{-1}, and exchangeable K, Ca and Mg 82, 117 and 260 and 330, 58 and 75 mg kg^{-1}, respectively. The DTPA extractable Zn was 1.42 and 0.84 mg kg^{-1}, respectively. The treatments of Zn consisted of 0, 5.0, 7.5, 10.0 and 15.0 kg Zn ha^{-1} as zinc sulphate in a randomized block design with four replications. Ginger was planted in a spacing of 30 cm x 30 cm in 3 m x 1 m beds with 40 plants each. The general package of practices recommended (20 t farm yard manure (FYM), 75:50:50 kg ha^{-1} of N, P_2O_5 and K_2O) was adopted in all the treatments. Full dose of FYM, Zn and P (as rock phosphate) was applied as basal dose and N (as urea) and K (as muriate of potash) were applied in two equal doses 45 and 90 days after planting (DAP). The soil samples were taken during critical stage (120 DAP) of crop growth. The DTPA soil extract (Lindsay & Norvell 1978) was analysed for Zn by atomic absorption spectrophotometer, by following standard procedures. Fresh rhizome yield per bed was recorded during harvest (8–9 months after planting). The data were analysed statistically and response functions were fitted in SPSS (V 10).

Soil Zn availability increased significantly with higher levels (10 and 15 kg ha^{-1}) of Zn application (Table 1). The highest DTPA-Zn was recorded at 15 kg ha^{-1} Zn application during both the years (10.6 and 15.2 mg kg^{-1}, respectively). The increase in DTPA extractable soil Zn concentration with fertilizer application followed a quadratic response with an R^2 value of 0.988 ($P<0.05$) (Fig. 1).

Application of Zn fertilizer significantly increased rhizome yield over control during both the years of study. However, higher levels of Zn application had no significant influence on yield during the first year. During the second year, there was significant difference in yield among higher levels of Zn application with the highest yield (12.3 kg bed^{-1}) in 5 kg ha^{-1} Zn application followed by 7.5 kg ha^{-1} Zn level. As the levels of Zn application increased the yield

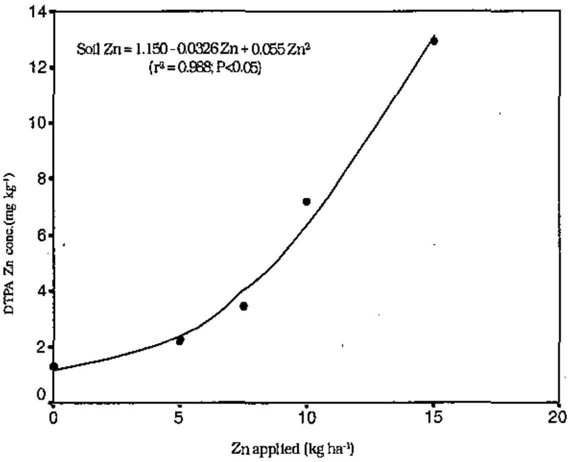

Fig 1. Soil DTPA-Zn concentration in relation to Zn fertilizer rates in ginger

response was reduced (Table 1). During the first year the initial DTPA-Zn concentration was slightly higher (1.4 mg kg^{-1}); during the second year the initial status was lower (0.84 mg kg^{-1}) and hence response to higher dose of Zn was also noticed. Gupta & Vyas (1999) also observed an economic response for applied Zn up to 3.0 kg ha^{-1} for soybean in soils with less than 0.5 mg kg^{-1} of DTPA-Zn and no response in soils having Zn content above that.

The mean yield of both the years also showed highest response at 5 kg ha^{-1} Zn application. The relationship between mean rhizome yield and fertilizer application rate was described satisfactorily by a cubic model with an R^2=0.96 (Fig. 2). From the response curve the optimum

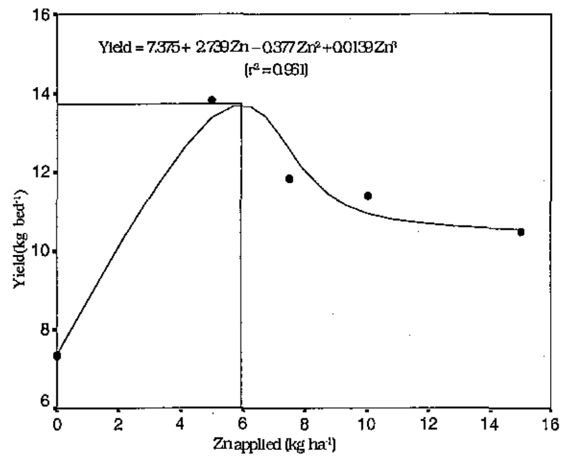

Fig 2. Yield response of ginger to applied Zn fertilizer

Table 1. Effect of Zn doses on soil Zn availability and rhizome yield of ginger

Zn level (kg ha^{-1})	Soil Zn (mg kg^{-1})			Yield (kg (3 m^2 bed^{-1}))		
	2001	2002	Mean	2001	2002	Mean
0	1.60	0.96	1.28	9.10	6.55	7.33
5.0	2.50	1.87	2.14	15.20	12.30	13.78
7.5	3.20	3.69	3.45	13.80	9.80	11.83
10.0	6.50	7.82	7.16	14.30	8.40	11.35
15.0	10.60	15.18	12.86	13.10	7.90	10.50
CD (P=0.05)	1.40	0.83		3.00	1.60	

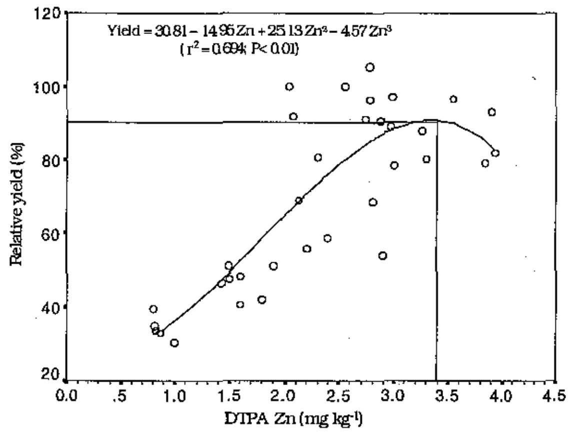

Fig 3. Yield response of ginger to soil DTPA-Zn concentration

fertilizer dose for obtaining maximum rhizome yield can be fixed as 6 kg ha^{-1} of Zn. The optimum dose for maximum grain yield of maize was fixed at 7.1 kg ha^{-1} of Zn in a quadratic response by Dwivedi *et al.* (2002).

The rhizome yield increased as the soil DTPA-Zn concentration increased up to a certain limit and declined when the soil Zn concentration reached higher values at higher fertilization rates. Since the absolute yields varied during both the years, the yield was expressed as per cent of maximum for each year ie., relative yield. The relationship of relative yield to soil DTPA-Zn concentration fitted significantly in a cubic model with an R^2=0.694 ($P<0.01$) (Fig. 3). The higher limit of soil DTPA-Zn for obtaining higher rhizome yield was worked out from the fitted response function and graph. The soil Zn concentration to get 90% of maximum relative yield in ginger was found to be 3.4 mg kg^{-1}. The maximum relative rhizome yield at 90% was considered because the yield was found to decrease with higher soil Zn concentration above this level. As the concentration of soil Zn increased above threshold level, it affected the yield by causing phytotoxicity and imbalance of nutrients.

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